ITO's Office
10S/9999604.

TF 1101

R-C Oscillator

INSTRUCTION MANUAL

10S/9999604

MARCONI INSTRUMENTS LIMITED

Alternative Colour Coding

or Mains Leads

Green seri-)

OPERATING AND MAINTENANCE HANDBOOK

for

R - C OSCILLATOR

TYPE TF 1101

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1968

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

M.I. 0.8c
3/70/B

EB 1101
4a - 3/70

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Chapter 1

General information

1.1 INTRODUCTION

The Marconi TF 1101 R-C Oscillator covers from 20 c/s to 200 kc/s in four ranges. It can develop a maximum of 20 V across a load of 600 Ω or greater. Lower outputs are obtained by means of a continuously-variable level control and a 600 Ω attenuator which is adjustable in seven 10 dB steps; the attenuator, and the meter monitoring its input level, are calibrated in open-circuit output voltage and also in decibels relative to 1 mW developed within a 600 Ω load. By means of oscillator stabilization, the output level, once set, remains virtually constant throughout the frequency range.

The total distortion present in the output is less than 0.5% between 50 c/s and 20 kc/s, and less than 1% outside this range. The distortion is within these limits when the output is fed via the attenuator; it is also within these limits with directly-connected loads, except that, for loads below 1000 Ω and/or with outputs above 10 V, the distortion may rise to 1.5%. A built-in 1 kc/s pass filter can be connected in series with the outlet of the instrument so that, at this frequency, an output having a harmonic content less than 0.1% is available for distortion measurements.

1.2 DATA SUMMARY

Frequency.	Four ranges:	20 c/s to 200 c/s. 200 c/s to 2000 c/s. 2 kc/s to 20 kc/s. 20 kc/s to 200 kc/s.
	Accuracy:	±1.5% ±1 c/s.
	Stability:	±0.15% ±1 c/s after warming-up.
	Response:	Flat to within ±0.5 dB of meter indication from 20 c/s to 200 kc/s, for any given setting of the output controls.
Output.	Direct:	Low impedance: continuously variable up to 20 V for external loads of 600 Ω or greater.
	Via 600 Ω attenuator:	Continuously variable up to 20 V source e.m.f. in seven steps with maxima: 20 mV, 60 mV 200 mV 600 mV, 2 V, 6 V and 20 V.
	The instrument is also calibrated from -60 to +26 dB relative to 1 mW, to show the power delivered to an external 600 Ω load.	
Distortion.	Via 600 Ω attenuator:	Less than 0.5% between 50 c/s and 20 kc/s. Outside this range, less than 1%.
	Direct:	As above except that, at output levels above 10 V and/or with loads less than 1 kΩ distortion may rise to 1.5%.
	Filtered:	At 1 kc/s, using the built-in band-pass filter, less than 0.1% with reduced output.

Distortion (continued).

Hum:	200 c/s to 200 kc/s: -60 dB. 20 c/s to 200 c/s: -50 dB.

Dimensions and weight:	Height	Width	Depth	Weight
	$12\frac{1}{4}$ in	$8\frac{1}{2}$ in	14 3/4 in	31 lb
	31 cm	21.5 cm	37.5 cm	14 kg

Chapter 2

Operation

2.1 INSTALLATION

Unless otherwise specified, the R-C Oscillator is normally dispatched with its valves in position and with its power transformer tappings adjusted for immediate connection to a 240 V a.c. supply. The tappings can be adjusted for operation from any supply voltage in the ranges 200 to 250 V and 100 to 150 V. To check or alter the settings of the power transformer tappings, refer to MAINTENANCE - section 4.4.

2.2 SWITCHING ON

Before switching on, be sure that the instrument is correctly adjusted for the voltage of the a.c. supply to be used.

Connect the power lead to the a.c. supply socket; the lead is stowed, when not in use, in clips and a dummy socket at the rear of the instrument. Switch ON by means of the SUPPLY switch. The pilot lamp should glow.

Allow several minutes to elapse for the instrument to warm up. A longer period, say half an hour, should be allowed when the highest stability is required.

2.3 ADJUSTING FREQUENCY

The four consecutive frequency bands covered by the instrument are selected by the four position RANGE switch. The 'c/s' scale on the FREQUENCY dial applies to the first two positions of the switch and the 'kc/s' scale to the second two positions; the scale indication must be multiplied by 10 at the second and fourth positions.

To set the instrument to a particular frequency, turn the RANGE switch to the appropriate position and adjust the FREQUENCY dial to the required frequency.

2.4 ATTENUATED OUTPUT

A the first seven clockwise positions of the ATTENUATOR switch, the source e.m.f., or open-circuit output voltage, is indicated by the OUTPUT meter, read in conjunction with the setting of the ATTENUATOR switch. The effective full-scale voltage reading of the meter is engraved by each position of the switch and the voltage is read off whichever of the two lower meter scales, 0-6 or 0-20, is appropriate; the colour of each engraving by the switch is in accordance with the colour of the scale which should be used.

For example, if an open-circuit output of 130 mV is required,

(1) set the ATTENUATOR switch to 200 mV (yellow), and

(2) adjust the SET LEVEL control so that the meter indicates '13' on the 0-20 scale (yellow).

Except when the 1 kc/s filter is required in circuit, the load should be connected between the left hand OUTPUT terminal and EARTH terminal. The source impedance, at the first seven positions of the ATTENUATOR switch, is 600 Ω. At the seventh position, where there is only a series 600 Ω resistor between the meter circuit and the outlet terminals, it is assumed that the SET LEVEL control is adjusted to maintain the meter indication at a given level in order that the voltage drop due to the source impedance of the output transformer - a low value of impedance owing to negative feedback - can be neglected. The output to a load depends upon the impedance of the load, as described in the following subsidiary sections.

2.4.1 Load impedance: 600 Ω (resistive)

The voltage developed across a 600 Ω resistive load, which matches the source impedance, is half the open circuit voltage indicated by the ATTENUATOR and meter.

For the particular case of a 600 Ω resistive load, there is a set of dBm figures engraved round the ATTENUATOR switch and a dBm scale on the meter. The figures and the scale are red. Addition of the dBm value indicated by the meter to the dBm figure at the ATTENUATOR position, gives the power developed in a 600 Ω resistive load in terms of decibels relative to 1 mW.

2.4.2 Load impedance: very high relative to 600 Ω

The voltage developed across a very high load impedance, exceeding say 100 kΩ, is substantially the open circuit voltage indicated by the ATTENUATOR and meter. This will usually be the case when the R-C oscillator is connected directly to the control grid of an amplifier valve, providing the preceding circuit (if any) is disconnected.

However, this direct reading becomes progressively in error for values of load below 100 kΩ. If the load has a purely resistive impedance of 60 kΩ, the voltage across it is of the order of only 1% less than the open circuit voltage, but with lower values of load the error becomes more serious and the user should refer to section 2.4.3.

Changes in output level can be read in dB from the dBm scale on the meter and the dBm engravings round the ATTENUATOR switch. Absolute dBm readings, however, are only valid when the load is 600 Ω, as described in sect. 2.4.1.

2.4.3 Load impedance: neither very high nor 600 Ω (resistive)

To determine the voltage developed across a load such as this, recourse must be made to the general expression:

$$\text{voltage across load} = \frac{E_S \times Z_L}{Z_S + Z_L}$$

where E_S is the source e.m.f., i.e. open circuit voltage, indicated by the ATTENUATOR and meter.

Z_L is the load impedance, which may consist of resistive and reactive components.

Z_S is the source impedance - in this case, 600 Ω resistive.

In particular, if the load is predominantly resistive, having a value R_L, then:

$$\text{voltage across load} = \frac{E_S \times R_L}{600 + R_L}$$

A series of approximate multiplying factors, which can be used to convert the indicated value of source e.m.f. to the actual voltage developed across a resistive load R_L, and which have been derived with the aid of the last expression, are given in Table 1 for a selection of load values.

TABLE 1

Load R_L ohms	voltage across R_L is the indicated source e.m.f. multiplied by:
60 000	0.99
20 000	0.97
8 000	0.93
4 000	0.87
2 000	0.77
1 000	0.625
800	0.57
600	0.50
400	0.40
300	0.33
200	0.25
150	0.20
100	0.143
75	0.111
50	0.077

Changes in output level can be read in dB from the dBm scale on the meter and the dBm engravings round the ATTENUATOR switch. Absolute dBm readings, however, are only valid when the load is 600 Ω, as described in Sect. 2.4.1.

2.4.4 Increasing the output impedance

If it is necessary to present the equipment under test with a source resistance of more than 600 Ω, e.g., to simulate the output impedance of an amplifier stage, then the output resistance of the R-C oscillator can be increased to the required value R_R by connecting a single resistor R_A in series with the OUTPUT terminal. The value of the resistor which must be added is:

$$R_A = R_R - 600\ \Omega$$

When a load R_L is connected to this arrangement

$$\text{voltage across load} = \frac{E_S \times R_L}{600 + R_A + R_L}$$

where E_S is the source e.m.f. indicated by the ATTENUATOR and meter.

2.4.5 Reducing the output impedance

If it is necessary to present the equipment under test with a source resistance of less than 600 Ω, then the output resistance of the R-C oscillator can be made equal to the required value R_R by shunting the OUTPUT terminal to the EARTH terminal with a resistor R_B, where

$$R_B = \frac{600 \times R_R}{600 - R_R} \Omega$$

Under these conditions, the effective source e.m.f., i.e., open circuit voltage, is

$$E_{SE} = \frac{E_{SI} \times R_B}{600 + R_B} \quad V$$

where E_{SI} is the source e.m.f. indicated by the ATTENUATOR and meter.

When a load R_L is connected to this arrangement

$$\text{voltage across load} = \frac{E_{SE} \times R_L}{R_R \times R_L}$$

2.5 DIRECT OUTPUT

At the DIRECT position of the ATTENUATOR switch, the meter indicates the voltage between the OUTPUT and EARTH terminals. Therefore, if a load is connected to these terminals, the indicated voltage is that developed across the load. This terminal voltage is read directly on the yellow scale of the meter, full-scale deflection corresponding to 20 V.

Changes in output level can be read in dB from the red dBm scale on the meter.

Owing to the negative feedback returned over the last three amplifier stages, the output impedance is low relative to 600 Ω. Typically, it may be 70 Ω from 20 c/s to 20 kc/s, rising to 100 Ω at 200 kc/s. However, the optimum value of load is 600 Ω (resistive); lower values of load than this result in greater distortion for the same output power.

Loads which are wholly or partly capacitive may cause oscillation to take place in the amplifier stages over which feedback is returned - regenerative feedback developing, at an unwanted frequency, over the path of normal negative feedback. Transient oscillation may take place over part of each cycle of output, or the oscillation may be continuous and dominate the output, depending on the composition of the load. As a guide, a purely capacitive load should not exceed 1000 pF, nor should a resistive load of 600 Ω be shunted by more than 5000 pF.

2.6 1 kc/s FILTERED OUTPUT

When there is a requirement for an audio signal having a very low harmonic content, e.g., for the purpose of measuring the distortion generated when the signal is passed through an amplifier, the built-in 1 kc/s pass filter should be used. This enables a 1 kc/s signal containing less than 0.1% distortion to be obtained from the R-C oscillator.

Connect the filter in series with the output of the R-C oscillator by linking together the left hand OUTPUT terminal and the 1 kc/s FILTER INPUT terminal. Then take the signal for the equipment under test from the 1 kc/s FILTER OUTPUT terminal and the earth terminal.

The filter should be used at exactly its pass frequency. This may not be precisely 1 kc/s. Therefore, when using the filter, set the R-C oscillator to 1 kc/s and then rock the FREQUENCY control to find the setting at which the equipment under test receives maximum output from the filter.

At its pass frequency, the filter introduces a loss of the order of 30 dB. At all frequencies, its input and output impedance is predominantly resistive and is approximately 600 Ω.

Chapter 3

Technical description

As shown by the block schematic diagram, the instrument consists basically of a two-valve Wien bridge oscillator followed by amplifier stages leading to a push-pull output stage, a level monitor, and an attenuator. Reference should be made to the circuit diagram when reading the circuit descriptions which follow.

3.1 OSCILLATOR CIRCUIT

The two oscillator valves are resistance-capacitance coupled pentodes, V5 and V6. Feedback from the anode of V6 is applied across a bridge, the four arms of which consist primarily of (1) the switched resistors R13-R20 in series with C5a, (2) the switched resistors R21-R28 in parallel with C5b, (3) the thermistor X1, and (4) resistor R32. The out-of-balance voltage developed by the bridge is applied as input to V5; oscillation takes place at the particular frequency which causes the voltage applied from the junction of arms (1) and (2) to be regenerative in phase.

By altering the values of the components in arms (1) and (2), the frequency of oscillation is adjusted. The four frequency ranges are obtained by switching the resistors. Continuous tuning within each range is effected by the ganged capacitors C5a and C5b. The trimmer capacitors, C7-C10, parallel with the switched resistors in arm (2), are employed for individual frequency range adjustments.

The thermistor, X1, which makes up the third arm of the bridge, automatically adjusts its value and controls the amplitude of the regenerative out-of-balance voltage so that the output of the oscillator is sinusoidal and has the same level at all frequencies.

The phase shift round the oscillator circuit tends to be modified as the frequency rises towards 200 kc/s; the change occurs mainly at the anode of V5. Compensation for this is provided by the trimmer C6, which is effective in arm (1) of the bridge on the 20 to 200 kc/s range and is adjusted so that the tuning law on this range corresponds to that obtained on the other three ranges.

3.2 AMPLIFIER STAGES

The output of the oscillator system is fed from the anode of V6 to the cathode follower V7. The cathode circuit of V7 includes a variable potentiometer, RV2, which serves as the SET LEVEL control; at this point it has negligible effect upon the oscillator circuit frequency. The signal developed at the slider of RV2 is applied to a triode amplifier employing half of the double triode V8. This stage is coupled to a phase-splitter circuit using the second half of V8. The two balanced outputs of the phase splitter are applied to the control grids of the two output tetrodes V9 and V10, in a push-pull transformer-coupled output stage.

Distortion in the amplifier chain is minimized by the use of a push-pull output stage and by negative feedback from the secondary of the output transformer, T2, to the cathode of the first triode, V8a. The use of negative feedback is extended above 20 kc/s by the automatic substitution of a ferrite-cored output transformer, T3, which preserves the feedback voltage in correct phase.

3.3 OUTPUT LEVEL CONTROL

When the ATTENUATOR switch, SC, is set fully counter-clockwise, there are six attenuator sections between the output transformer and the outlet terminals. As the switch is turned clockwise to the sixth position, five of these attenuator sections are progressively withdrawn. A series 600 Ω resistor alone is inserted between the transformer and the terminals at the seventh position. At each of these first seven positions of the switch, the OUTPUT meter indication represents the source e.m.f., the bridge a.c. voltmeter circuit being connected directly to the output transformer. The seven 10-dB steps of attenuation and the continuously variable SET LEVEL control, used in conjunction with scales on the meter, provide calibrated open-circuit outputs from 1 mV to 20 V at a source impedance of 600 Ω.

At the DIRECT position of the ATTENUATOR switch, the secondary of the output transformer is

directly connected to the outlet terminals. The a.c. voltmeter circuit is then in parallel with the terminals and the meter indicates the voltage developed across a load. Up to 20 V can be obtained across a load of 600 Ω.

The ATTENUATOR switch and the meter are also calibrated in decibels relative to 1 mW, showing the power developed in an external 600 Ω load.

3.4 1 KC/S FILTER

The 1 kc/s pass filter, contained in the instrument, has its terminals on the front panel and can be linked in series with the normal OUTPUT terminal if required. At the pass frequency, the filter introduces a loss of the order of 30 dB and reduces the harmonic content of the output to less than 0.1%.

The filter consists of a symmetrical T network employing resistors, R84 and R85, in its two series arms and a parallel tuned circuit, L1 and C27, in its shunt arm. The values of the resistors, and the dynamic resistance of the tuned circuit, are such that the input and output impedance is 600 Ω at the pass frequency, and drops only a little at other frequencies; the input and output impedance is predominantly resistive at all frequencies and is substantially independent of the load and source impedance respectively.

3.5 POWER SUPPLY

The power transformer, T1, has two tapped primary windings which, by series or parallel connection, permit operation from supplies of 200 to 250 V or 100 to 150 V, 40 to 100 c/s.

The h.t. supply circuit includes the full-wave rectifier V1, followed by a series stabilizing arrangement consisting of the series regulator, V2, its control valve V3, and the reference tube V4.

Chapter 4

Maintenance

4.1 GENERAL

The following items are included in this handbook to assist in the maintenance of the R-C Oscillator type TF 1101:

Mains input connections diagram
Block schematic diagram
Circuit diagram
Component layout illustrations:-
- Front and rear panels
- General view (showing covers removed)
- Right hand side (general view)
- Right hand side (oscillator box)
- Left hand side (power supply section and attenuator)
- Left hand side (oscillator and amplifier section)

List of replaceable parts with circuit references
Valve replacement data sheets

Chapter 3, Technical Description, in this handbook, deals with the performance and internal circuits of the R-C oscillator and is intended to be read in conjunction with the block diagram and the circuit diagram. It is strongly recommended that the user should familiarize himself with this information before commencing the adjustment or replacement of component parts of the instrument.

The circuit diagram shows all the electrical components contained in the instrument. The description of these components - their type, value, rating, etc. - is given in the list of replaceable parts which also lists certain selected mechanical components.

The physical location of the electrical components is shown by the component layout illustrations.

4.2 FUSES

The TF 1101 is fitted with three fuses. Two of these, FS1 and FS2, are in series with the supply input connections to the power transformer, T1. The third, FS3, is in series with the chassis connection from the centre tap of the h.t. secondary winding of T1. The three fuse holders are accessible at the rear of the instrument.

4.3 REMOVAL OF COVERS

In addition to the front and rear panels, the R-C oscillator is enclosed by three covers, which together form the top, sides, and bottom of the complete instrument.

To remove these covers:

(1) Stand the instrument on its front face.

(2) Withdraw the four 2 BA screws - two above and two below the supply lead clips - from the rear panel.

(3) Raising the rear panel and its surround, remove the top cover; then remove the other two covers, which remain standing in the groove behind the front panel and its surround.

(4) To lift off completely the rear panel and its surround, detach the supply lead from its clips and thread it through the panel as the latter is removed. The plug on the supply lead can be passed through the rear panel after removing the transparent cover plate which is held in position by one screw.

The covers are reassembled by proceeding in the reverse order to that detailed above; ensure that the covers fit into the groove behind the front panel and surround as this assembly is replaced.

WARNING: When the TF 1101 is switched on, the top cap of V2 carries a high potential.

The illustration MP 1101-2 shows the instrument standing on its face, and the covers removed. In this picture, the rear panel, which has been raised to release the covers, remains lying on the rear end of the chassis.

4.4 SUPPLY INPUT ARRANGEMENTS

For reference while reading the following, open out the mains input connections diagram included after the end of this section.

The R-C oscillator is fitted with a power transformer, T1, having two separate tapped primary windings. By means of these, the instrument can be set to operate from supplies in the ranges 200 to 250 V and 100 to 150 V, 40 to 100 c/s. There are two forms of adjustment: (A) the linking of tags on the transformer to make the instrument suitable for whichever voltage range, of the two above, covers the anticipated supplies, and (B) the tap selection for a particular voltage in the range. In more detail:-

(A) For supplies within the range 200 to 250 V, the two primary windings must be connected in series by a link between the tags marked 'TAP A' and 'TAP B' on the transformer.

For supplies within the range 100 to 150 V, the major sections of the two primary windings must be connected in parallel by a link between the tags marked '100 V/200V' and 'TAP A', and a link between the tags marked 'TAP B' and '0 V', on the transformer.

(B) For a particular voltage, within either range, adjustment is made at a separate tapping panel, connected to the transformer but situated at the rear of the instrument. The supply input is carried by two fly leads, which must be screwed to the combination of taps appropriate for the supply voltage. The tapping panel carries a reversible reference plate, marked on one side with voltages applicable to the 200 to 250 V range, and on the other with voltages applicable to the 100 to 150 V range.

Example: For a 210 V supply, 'TAP A' should be linked to 'TAP B' on the transformer, the tapping panel reference plate should be positioned to show the markings for the 200 to 250 V range, and the fly leads should be connected to the '200' and '+10' positions on the panel.

In order to examine fully the transformer connections, remove the covers from the instrument, as described in Sect. 4.3. If it is only required to view the tapping panel, this can be seen through a transparent cover plate on the rear panel of the instrument; to alter the position of the fly leads, DISCONNECT THE SUPPLY and remove the cover plate, which is held in position by a single screw at its top end.

The 180 volt tap, included on the power transformer, is not employed in this instrument.

4.5 ACCESS TO OSCILLATOR BOX

The interior of the oscillator box is shown in the component layout illustration MP 1101-4.

The majority of the components of the two valve oscillator circuit and the succeeding cathode follower are screened by enclosure in this box, which is on the right hand side of the chassis. The valves V5, V6 and V7, included in these circuits, are mounted on the left hand side of the chassis, where the latter forms one side of the box, so that the tags of the valve holders project within the box.

To detach the cover, which forms three sides of the box, remove the ten screws that can be seen at the ends - four above the box, two at the side, and four below. Then, draw the cover off the supporting ends of the box, away from the chassis.

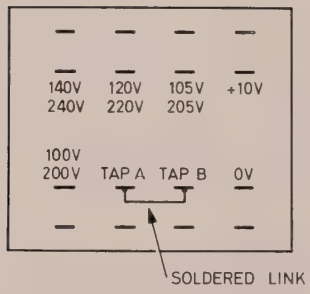
When replacing the cover, ensure that the holes through which the oscillator trimmer capacitors can be adjusted are at the bottom, opposite the trimmers.

4.6 WORKING VOLTAGES

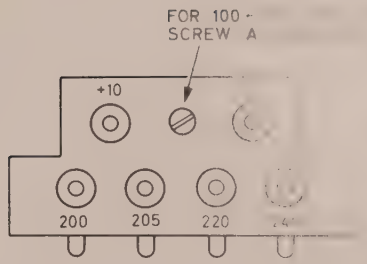
The voltages given in Table 2 and Table 3 are for guidance only in maintaining the TF 1101; identical values should not be expected on an individual instrument owing to the normal tolerances of valve performance and other circuit values.

The meter employed should be an Avometer Model 8 (20,000 Ω/V) or a meter having a similarly high resistance.

The supply voltage must be as near as possible to the value for which the instrument is adjusted.

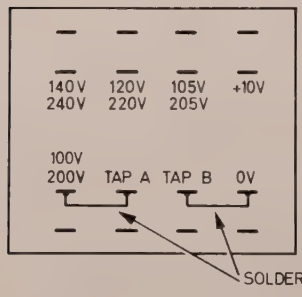


(1) FOR 200 - 250V SUPPLIES

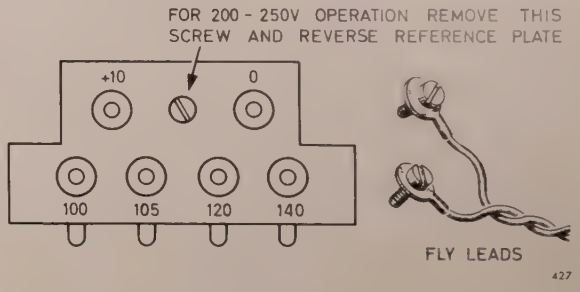


MAINS TRANSFORMER PRIMARY TAG CONNECTIONS

MAINS TAPPING PANEL. CONNECT FLY LEADS TO
VOLTAGE. ONE FLY LEAD MUST GO TO EITHER +10 OR



(2) FOR 100 - 150V SUPPLIES



MAINS INPUT CONNECTIONS

M.I. LTD. 1a—7/65
B.W. 2.5c 3/70

TABLE 2

Internal supply voltages

Supply	Measured between	Voltage
L.T.1	LT1 tags on transformer T1*	6.3 V a.c.
L.T.2	LT2 tags on transformer T1*	6.3 V a.c.
L.T.3	LT3 tags on transformer T1*	5.0 V a.c.
H.T., a.c.	Each HT1 tag on T1 and chassis	340 V a.c.
H.T., rectified	Cathode of V1 and chassis	360 V d.c.
H.T., stabilized (set by RV1)	Cathode of V2 and chassis	250 V d.c.

* WARNING: Tags LT1, LT2 and LT3 on T1 are at a high potential with respect to chassis.

TABLE 3

Valve electrode voltages
(d.c., with respect to chassis)

Valve No.	Anode (V)	Screen (V)	Cathode (V)
V2	360	381	250
V3	230	120	85
V4	85	-	0
V5	163	175	5.8
V6	128	86	1.6
V7	250	250	165
V8a	123	-	3.5
V8b	170	-	83
V9	241	250	18
V10	241	250	18

4.7 REPLACEMENT OF VALVES AND CRYSTALS

The types of valves used in the instrument, their base connections, and some guidance as to suitable alternatives if the types originally fitted are not readily available, are given in the valve replacement data sheets.

All valves and crystals are immediately accessible on removing the covers from the instrument as described in Sect. 4.3.

With the exception of V6, V9 and V10, the valves and crystals may normally be replaced without special selection. When replacing any of these three, it may be necessary to select the new valve in order to keep the harmonic content of the output within the specified limits; refer to Sect. 4.9.4 when replacing V6, and refer to Sect. 4.9.5 when replacing V9 or V10.

Replacement of valves may necessitate either the reselection of associated components or readjustment of associated preset controls; aspects of this are discussed in Sect. 4.8 - preset and specially selected components.

4.8 PRESET AND SPECIALLY SELECTED COMPONENTS

In the manufacturing data for the TF 1101, certain of the components are either specified as being of the preset type or designated for individual selection, the setting or selection of the components being carried out during the factory calibration of the instrument; this is necessary since the operating characteristics of the instrument have to conform to a quantitative specification including both maximum and minimum limits.

Components that are preset are described as such in the list of replaceable parts. Components that are individually selected are distinguished by a dagger against their normal value in the list.

If, in servicing a TF 1101, it is necessary to replace any of these components, it is also necessary, if the performance or accuracy of the instrument is not to be impaired, to repeat the factory procedure by which the component was originally adjusted or selected.

Again in any servicing involving the replacement of a valve, or a component which is neither preset nor selected, the user should consider carefully the possible effect on the performance of the circuit involved; if the performance has been set previously by means of a preset or selected component, it may be necessary to readjust or reselect that component in addition to replacing the faulty one.

Sect. 4.9 contains, in a series of subsidiary sections, a range of tests by which the main points of the performance of the instrument can be checked; these sections also deal with the adjustment of preset components and with the choice of valve of individually selected components. Table 4 lists the circuit reference numbers of both types of component together with the numbers of the sections in which their adjustment or selection is described.

TABLE 4

Preset component	Section describing adjustment	Selected component	Section describing adjustment
RV1	4.9.2	R14	4.9.3
RV3	4.9.6	R16	4.9.3
		R18	4.9.3
C6	4.9.3		
C7	4.9.3	R20	4.9.3
C8	4.9.3	R22	4.9.3
		R24	4.9.3
C9	4.9.3		
C10	4.9.3	R26	4.9.3
		R28	4.9.3
		R50	4.9.5
		R52	4.9.5
		R64	4.9.8
		C18	4.9.7
		C27	4.9.11

4.9 SCHEDULE OF TESTS

The following sections, based largely on the internal test schedule to which the instrument was produced, are included to enable the user to carry out a series of tests by which the main points of performance of the instrument can be checked. The sections also give details concerning the adjustment of preset components and the choice of value of individually selected components.

4.9.1 Apparatus required

(a) Multi-range meter, a.c. and d.c. voltages; e.g., Avometer 8.

(b) Variable mains supply transformer; e.g. Variac.

(c) Cathode-ray oscilloscope, preferably with built-in facilities for voltage measurement; e.g. M.I. TF 2200 Series.

(d) Wheatstone bridge.

(e) Audio and ultrasonic generator, covering 20 c/s to 100 kc/s; frequency accuracy, 0.2%; e.g., decade oscillator.

(f) Wave analyser; e.g. M.I. TF 455 Series or TF 2330.

(g) Receiver, with signal strength meter, covering a frequency range extending from the top frequency of item (f) up to 600 kc/s.

(h) Standard signal generator, having a frequency range as item (g); e.g. M.I. TF 867 or TF 2002 Series.

(i) Valve voltmeter; e.g. M.I. TF 1041 Series or TF 2604.

(j) Variable attenuator, 600 Ω; e.g. M.I. TF 2162. Standardized to secure maximum accuracy.

(k) 600 Ω load, 1 W.

(l) Decade capacitor, or fixed and variable capacitors, providing known capacitance of 1000 pF and 5000 pF.

(m) Sensitive valve voltmeter, e.g. M.I. TF 2600.

4.9.2 H.T. and l.t. supplies

Apparatus required: items (a), (b) and (c)

Set the a.c. supply voltage so that it is exactly the value for which the R-C oscillator is adjusted on its tapping panel.

Adjust the preset variable resistor RV1 so that the stabilized h.t. voltage at the cathode (pin 3) of V2, relative to chassis, is 250 V d.c. Then check that the other internal supply voltages compare satisfactorily with those given in Sect. 4.6.

Measure the stabilized h.t. voltage at the cathode of V2 while varying the a.c. supply voltage ±10%; the stabilized h.t. should not change more than ±0.5 V.

Connect the oscilloscope to the stabilized h.t. line (cathode of V2) and examine the ripple waveform; its peak-to-peak amplitude must not exceed 6 mV. (If the oscilloscope does not have facilities for voltage measurement, it must be calibrated beforehand on a known source so that voltages of this order can be measured.)

4.9.3 Adjustment of oscillator frequency ranges

Apparatus required: items (c), (d) and (e)

(1) Remove the cover of the oscillator box, as described in Sect. 4.5.

(2) Apply the waveform available at the OUTPUT terminal (or at the junction of C17 and R43) to one pair of deflecting plates of the oscilloscope, and the output of the decade oscillator to the other pair of plates. With this arrangement the frequency of the TF 1101 can be checked against that of the decade oscillator by means of the Lissajous figures seen on the oscilloscope.

(3) Turn the RANGE switch to C/S X 10. Adjust resistors R16 and R24 at the l.f. end of the range of the FREQUENCY control, and C8 at the h.f. end, so that the correct output frequencies are obtained when the effective dial indication is 200 c/s and 2000 c/s. If a blank dial is to be calibrated, adjust R16, R24 and C8, so that a coverage in reasonable excess of 200-2000 c/s is obtained and then mark the dial at these frequencies.

The total resistance of R15 and R16 must be within ±2% of that of R23 plus R24.

(4) Turn the RANGE switch to C/S X 1. Adjust R14 and R22 at the l.f. end of the range, and C7 at the h.f. end, so that the correct output frequencies are obtained when the dial indicates 20 c/s and 200 c/s. If a blank dial is to be calibrated, these end-of-range frequencies should be obtained at the marks made for 200 c/s and 2000 c/s in (3). R13 plus R14 must be within ±2% of R21 plus R22.

(5) Turn the RANGE switch to KC/S X 1. Adjust R18 and R26 at the l.f. end of the range, and C9 at the h.f. end so that the correct output frequencies are obtained when the dial indicates 2 kc/s and 20 kc/s. If a blank dial is to be calibrated, these end-of-range frequencies should be obtained at the marks made for 200 c/s and 2000 c/s in (3). R17 plus R18 must be within ±2% of R25 plus R26.

(6) Turn the RANGE switch to KC/S X 10. Adjust R20 and R28 at the l.f. end of the range, and C10 at the h.f. end, so that the correct output frequencies are obtained when the effective dial indication is 20 kc/s and 200 kc/s; C6 should be set to the least capacity that will permit C10 to be satisfactorily adjusted. If a blank dial is to be calibrated, the end-of-range frequencies should be obtained at the marks made for 200 c/s and 2000 c/s in (3). R19 plus R20 must be within ±2% of R27 plus R28.

(7) Replace the oscillator box cover, ensuring that the holes allowing adjustment of the trimmer capacitors are at the bottom of the instrument. Check that, with the cover in position, the correct frequency is still obtained at the h.f. end of each range when the dial is set to the end-of-range position engraved or marked; if necessary, adjust the appropriate trimmer capacitor on each range.

The end-of-range frequency calibrations should be finally checked, or made, when the instrument is known to be satisfactory in other respects and has been fully assembled and switched on for 30 minutes with the correct supply voltage applied. This may form part of a complete check, or calibration, of the whole frequency dial as described in Sect. 4.9.14.

4.9.4 Oscillator distortion

Apparatus required: items (f), (g) and (h)

Usually, it is sufficient to test the overall distortion appearing at the OUTPUT terminal. However, when the overall distortion is excessive, to determine whether the fault lies in the oscillator circuit, the distortion in the output of this stage should be measured.

Take the signal for analysis from the junction of C17 and R43. This point must not be shunted to chassis by the input impedance of the test apparatus if it is low; to prevent this, a series resistor, of say 100 kΩ, should be inserted in series between the TF 1101 and the test apparatus.

The 2nd and 3rd harmonic content at the junction of C17 and R43 should be approximately the same as, or less than, that listed for several operating frequencies in Table 5. These tabulated values are for guidance only, the primary aim being that the harmonic content in the output of the instrument should be within the limits given in Sect. 4.9.6.

Measurements may be made with the wave analyser, or, at frequencies above the range of the analyser, by means of the receiver; the sensitivity of the latter must be checked against this signal generator at each component frequency.

TABLE 5

RANGE switch	FREQUENCY dial	2nd harmonic	3rd harmonic
C/S X 1	60 c/s	0.3%	0.2%
C/S X 1	200 c/s	0.3%	0.2%
C/S X 10	200 c/s	0.3%	0.2%
C/S X 10	2000 c/s	0.3%	0.1%
KC/S X 1	2000 c/s	0.3%	0.1%
KC/S X 1	5000 c/s	0.3%	0.1%
KC/S X 1	20 kc/s	0.8%	0.3%
KC/S X 10	20 kc/s	0.8%	0.3%
KC/S X 10	200 kc/s	0.8%	0.3%

When replacing V6, it may be necessary to select the new valve in order to obtain sufficiently low levels of harmonic content in the oscillator output.

4.9.5 Output amplifier: preliminary requirements

(1) The anode and cathode loads, R50 and R52, of the phase-splitter amplifier, V8b, must be matched in resistance value to within 3%.

(2) The push-pull output valves, V9 and V10, must be a matched pair. This matching must be preserved if either is replaced. A selection can be carried out on a valve characteristic meter; the pair should be such that, with 225 V at the anode, 225 V at the screen grid, and -17.5 V at the control grid, the higher anode current is within 2% of the lower, and the mutual conductance of one is almost identical with that of the other. Correct pairing of the valves will be confirmed if the output distortion of the instrument at the l.f. end of its range is satisfactorily low in the check described in Sect. 4.9.6.

4.9.6 Output distortion and hum

Apparatus required: items (f), (g) and (h)

Make distortion and hum measurements at a wide selection of frequencies with (a) the measuring apparatus connected to the OUTPUT and EARTH terminals, (b) the ATTENUATOR switch at DIRECT, and (c) the SET LEVEL control adjusted so that the meter indicates 20 V.

The output of the TF 1101 should contain less than 0.5% distortion between 50 c/s and 20 kc/s, and less than 1% distortion outside this range. These limits apply when the output is fed via the attenuator, and also with directly-connected loads down to 600 Ω, except that, with directly-connected loads below 1000 Ω the distortion may rise to 1.5% at frequencies above 50 kc/s.

From 200 c/s to 200 kc/s, the hum level should be -60 dB relative to the output signal. Below 200 c/s, there is some rise in the hum level. Adjust the preset variable resistor, RV3, below V1, to minimize the hum. (RV3 was not fitted on early models of TF 1101.)

Measurements may be made with the wave analyser, or, at frequencies above the range of the analyser, by means of the receiver; the sensitivity of the latter must be checked against the signal generator at each component frequency.

4.9.7 Output frequency characteristic

Apparatus required: item (m)

(1) Turn the ATTENUATOR switch to DIRECT.

(2) Measure the frequency characteristic of the output voltage over the complete range 20 c/s to 200 kc/s; the variation must not be greater than 1 dB. If this requirement is not achieved at the higher frequencies, the response should be flattened by adjustment of the value of C18 in the cathode circuit of V7.

(3) Measure the frequency response of output voltage for constant setting of the TF 1101 meter of 20 V over the range 20 c/s to 200 kc/s; the variation must not exceed the limit given in data summary Sect. 1.2.

4.9.8 Meter sensitivity and linearity

Apparatus required: item (i)

For this test, the errors of the valve voltmeter employed must be known so that measurements at 4, 8, 12, 16 and 20 V can be made with high accuracy.

(1) Connect the valve voltmeter across the OUTPUT and EARTH terminals.

(2) Turn the ATTENUATOR switch to DIRECT.

(3) With the RANGE switch at C/S X 10, set the frequency of the TF 1101 to 200 c/s.

(4) With the covers off the instrument, adjust the value of R64 (by substitution or addition) so that the meter on the TF 1101 reads 20 V when the true output is 19.8 V.

The error introduced in (4), whereby the indication is made 1% high while the covers are off, is compensation for the effect of higher temperature in the instrument when the covers are on.

When the covers are on the instrument, check that the true output agrees reasonably with the indication when the latter is 4, 8, 12 and 16 V, as well as confirming that the accuracy is satisfactory at 20 V. Make this test at 200 c/s and 200 kc/s.

4.9.9 Attenuator accuracy

Apparatus required: items (f) and (j)

(1) Connect the 600 Ω attenuator between the outlet terminals (OUTPUT and EARTH) of the TF 1101 and the wave analyser. The latter serves as a sensitive indicator in this test.

(2) Adjust the external attenuator to 70 dB.

(3) Set the TF 1101 to a frequency of 1 kc/s.

(4) Turn the ATTENUATOR switch to 20 V (+20 dBm).

(5) Adjust the SET LEVEL control so that the meter of the TF 1101 indicates 20 V.

(6) Adjust the wave analyser to obtain a convenient reference indication.

(7) Turn the ATTENUATOR switch counter-clockwise so that the output of the TF 1101 is reduced in steps of nominally 10 dB. At each step, first ensure that the TF 1101 meter reads 20 V (readjusting the SET LEVEL control if necessary), then adjust the external attenuator to restore the reference indication on the wave analyser.

In general, it should be found that each step of the ATTENUATOR switch requires to be offset by a change in the external attenuator of 10 dB within approximately ±0.5 dB, and that the overall change of output level from the TF 1101 is 60 dB within approximately ±1.0 dB.

4.9.10 Stability

Apparatus required: items (c), (k) and (l)

(1) Connect the capacitor, set to minimum, across the left hand OUTPUT and EARTH terminals. Also, connect the oscilloscope across these terminals.

(2) Turn the ATTENUATOR switch to DIRECT and adjust the SET LEVEL control to 20 V.

(3) With the RANGE switch set in turn to KC/S X 1 and KC/S X 10, increase the capacity from minimum until the onset of instability is seen on the waveform displayed on the oscilloscope.

At both settings of the RANGE switch, it should be possible to make the capacitive load exceed 1000 pF before instability occurs.

(4) Connect the 600 Ω load across the OUTPUT and EARTH terminals, in parallel with the capacitor and the oscilloscope.

(5) With the RANGE switch set in turn to KC/S X 1 and KC/S X 10, increase the capacity from minimum until the onset of instability is seen on the waveform displayed on the oscilloscope.

At both settings of the RANGE switch, it should be possible to make the parallel capacitive component of the load exceed 5000 pF before instability occurs.

4.9.11 1 kc/s Filter: Frequency

Apparatus required: items (i) and (k)

(1) Connect the internal 1 kc/s pass filter in series with the output of the TF 1101 by linking the left hand OUTPUT terminal to the 1 kc/s FILTER INPUT terminal.

(2) Connect the 600 Ω load and the valve voltmeter in parallel across the 1 kc/s FILTER OUTPUT and EARTH terminals.

(3) Turn the ATTENUATOR switch to 20 V (+20 dBm).

(4) Set the RANGE switch to C/S X 10 and adjust the frequency of the TF 1101, close to 1000 c/s, until maximum output is indicated by the valve voltmeter.

The frequency as indicated by the dial of the TF 1101, at which the filter passes maximum output may be expected to lie within approximately 100 c/s of 1000 c/s. If necessary, select a capacitor for position C27, so that the frequency is brought within the required limits.

4.9.12 1 kc/s Filter: Insertion loss

Apparatus required: items (i) and (k)

(1) Set the TF 1101 to a frequency of 1000 c/s.

(2) Connect the valve voltmeter and the 600 Ω load in parallel across the left hand OUTPUT and EARTH terminals.

(3) Turn the ATTENUATOR switch to 600 mV

(-10 dBm) and adjust the SET LEVEL control so that the meter on the TF 1101 reads -2 dB on the dBm scale.

(4) Adjust the range selector on the valve voltmeter to obtain a convenient reference reading.

(5) Transfer the connections of the 600 Ω load and the valve voltmeter from the left hand OUTPUT terminal to the 1 kc/s FILTER OUTPUT terminal. Link the left hand OUTPUT terminal to the 1 kc/s FILTER INPUT terminal.

(6) Turn the ATTENUATOR switch to 20 V (+20 dBm). Adjust the frequency of the TF 1101 to obtain maximum deflection on the valve voltmeter. Then, adjust the SET LEVEL control to restore the indication of the valve voltmeter to the reference level previously obtained in (4).

The difference in output from the TF 1101, as indicated by the ATTENUATOR switch and the dBm scale on the meter, between (4) and (6) is the insertion loss of the filter; it should be 31 dB within approximately ±4 dB.

4.9.13 1 kc/s Filter: Distortion in output

Apparatus required: items (f) and (k)

(1) Link the left hand OUTPUT terminal to the 1 kc/s FILTER INPUT terminal. Connect the 600 Ω load and the wave analyser in parallel across the 1 kc/s FILTER OUTPUT and EARTH terminals.

(2) Turn the ATTENUATOR switch to DIRECT.

(3) Adjust the frequency of the TF 1101, close to 1000 c/s, until maximum output through the filter is obtained, as indicated by the wave analyser.

(4) Adjust the SET LEVEL control so that the meter reads 20 V.

(5) Measure the output of the filter at its pass frequency and at the 2nd and 3rd harmonics of the pass frequency.

The total harmonic content in the output of the filter must not exceed 0.1%.

4.9.14 Frequency dial calibration

Apparatus required: items (b), (c) and (e)

The following procedure may be employed to check the accuracy of an existing calibrated dial on the instrument or to calibrate a blank dial if it has been necessary to replace the original one. The frequency coverage of each range should previously have been checked, or set, as described in Sect. 4.9.3.

(1) Apply the mains voltage for which the TF 1101 is adjusted and allow the instrument to warm up for 30 minutes. The covers should be on the instrument.

(2) Apply the waveform available at the OUTPUT and EARTH terminals to one pair of deflecting plates in the oscilloscope and apply the output of the decade oscillator to the other pair of plates.

(3) By reference to the Lissajous figures displayed on the oscilloscope, check that the accuracy of the dial calibration is ±1.5% ±1 c/s; if the calibration error exceeds this limit on any range, it may be possible to reduce the error to an acceptable value by appropriate readjustment of the coverage of the range as described in Sect. 4.9.3.

If a blank dial is to be calibrated, switch the instrument to the 200- to 2000 c/s range. Then, by reference to the Lissajous figures on the oscilloscope, mark the blank dial at every 5 c/s from 200 c/s to 300 c/s, every 10 c/s from 300 c/s to 1000 c/s, every 20 c/s from 1000 c/s to 1500 c/s, and every 50 c/s from 1500 c/s to 2000 c/s. Subsequently, the outer scale of the dial should be engraved in accordance with these marks. The inner scale is obtained by projection of the outer scale.

Chapter 5

Replaceable parts

Introduction

This section lists replaceable parts in alphabetical order of their circuit references, with miscellaneous parts at the end of the list. The following abbreviations and symbols are used:-

C	:	capacitor
Carb	:	carbon
Cer	:	ceramic
Elec	:	electrolytic
FS	:	fuse
L	:	inductor
M	:	meter
MR	:	semiconductor diode
PL	:	plug
R	:	resistor
RV	:	variable resistor
S	:	switch
SKT	:	socket
T	:	transformer
†	:	value selected during test; nominal value listed
W	:	watts at 70 °C
X	:	thermistor

Ordering

Send your order for replacement parts to our Service Division at the address given on the back cover. Specify the following information for each part required:

1) Type and serial number of instrument
2) Circuit reference
3) Description
4) M.I. code number

If a part is not listed, state its function, location and description when ordering.

Circuit reference	*Description*	*M.I. code*
C1	Elec 8μF -20+50% 450V	61-TF 1101
C2	Elec 32μF -20+50% 450V	26427-801
C3	Paper 0.25μF 20% 350V	63-TF 1101
C4	Elec 8μF -20+50% 450V	61-TF 1101
C5	Var air 4-gang, 523pF swing	64-TF 1101
C6	Var air 4 to 16.5pF preset	26812-285
C7	Var air 4 to 16.5pF preset	26812-285
C8	Var air 4 to 16.5pF preset	26812-285
C9	Var air 4 to 16.5pF preset	26812-285
C10	Var air 4 to 16.5pF preset	26812-285
C11	Mica 47pF 5% 350V	26252-139
C12	Mica 39pF 5% 350V	26252-138
C13	Paper 0.1μF 10% 400V	26512-232
C14	Elec 8μF -20+50% 450V	61-TF 1101
C15	Elec 8μF -20+50% 450V	61-TF 1101
C16	Paper 0.1μF 10% 400V	26512-232
C17	Paper 1μF 25% 150V	71-TF 1101
C18	Cer 22pF 5% 750V	26324-807
C19	Cer 22pF 10% 500V	70-TF 1101
C20	Paper 0.1μF 10% 400V	26512-232
C21	Paper 0.5μF 20% 350V	69-TF 1101
C22	Paper 0.5μF 20% 350V	69-TF 1101
C23	Paper 0.001μF 20% 600V	26174-125
C24	Paper 0.001μF 20% 600V	26174-125
C25	Elec 32μF -20+50% 450V	26427-801
C26	Mica 330pF 5% 350V	60-TF 1101
C27	Elec 25μF -20+100% 25V	8-TM 5178
C28	Cer 5.6pF 10%	11-TM 5285
C29	Paper 0.1μF 10% 350V	26174-173
C30	Cer 47pF 10% 750V	26324-835
FS1	Cartridge 3A	115-TF 1101
	Holder for FS1	TB 24330/1
FS2	Cartridge 3A	115-TF 1101
	Holder for FS2	TB 24330/1
FS3	Cartridge 250mA	116-TF 1101
	Holder for FS3	TB 24330/1
L1	Filter inductor	44414-003

Circuit reference	Description	M.I. code
M1	Moving coil, 200 μA f.s.d., TM 5170/1 500Ω (nominal), special scale; including clamping brackets	
MR1	CG1-E (CV425) Germanium crystal rectifier	5-TM 5285
MR2	CG1-E (CV425) Germanium crystal rectifier	5-TM 5285
PLP1	Pilot lamp, miniature bayonet cap (centre contact) 6.3V, 0.15A	80-TF 1101
	Pilot lamp holder; including red lens	79-TF 1101
R1	Carb 1kΩ 10% ¼W	24342-080
R2	Carb 100Ω 10% ¼W	24342-050
R3	Carb 4.7kΩ 10% ¼W	24342-100
R4	Carb 680kΩ 10% ¼W	24342-158
R5	Carb 330kΩ 10% ¼W	24342-148
R6	Carb 47kΩ 10% ¼W	24342-126
R7	Carb 100kΩ 10% ½W	24343-158
R8	Carb 1kΩ 10% ¼W	24342-080
R9	Carb 47kΩ 10% ½W	24343-126
R10	Carb 68kΩ 10% ½W	24343-131
R12	Carb 10Ω 10% ½W	24343-020
R13	Carb 6.2MΩ 2% 3/4W	20-TF 1101
R14 †	Carb 820kΩ ½W	24343-161
R15	Carb 620kΩ 2% 3/4W	22-TF 1101
R16 †	Carb 82kΩ ½W	24343-133
R17	Carb 62kΩ 2% ¼W	24-TF 1101
R18 †	Carb 8.2kΩ ¼W	24342-133
R19	Carb 6.2kΩ 2% ¼W	26-TF 1101
R20 †	Carb 820Ω ¼W	24342-078
R21	Carb 6.2MΩ 2% 3/4W	20-TF 1101
R22 †	Carb 820kΩ ½W	24343-161
R23	Carb 620kΩ 2% 3/4W	22-TF 1101
R24 †	Carb 82kΩ ½W	24343-133
R25	Carb 62kΩ 2% ¼W	24-TF 1101
R26 †	Carb 8.2kΩ ¼W	24342-108
R27	Carb 6.2kΩ 2% ¼W	26-TF 1101
R28 †	Carb 820Ω ¼W	24342-078
R29	Carb 4.7kΩ 10% ¼W	24342-100
R30	Carb 47kΩ 10% ¼W	24342-126
R31	Carb 22kΩ 10% ¼W	24342-118
R32	Carb 2.2kΩ 10% ¼W	24342-088
R33	Carb 3.3kΩ 10% 3/4W	24343-094
R34	Carb 10kΩ 10% 1W	24345-710
R35	Carb 47kΩ 10% ½W	24343-126
R36	Carb 4.7kΩ 10% ¼W	24342-100
R37	Carb 680kΩ 10% ¼W	24342-158
R38	Carb 150Ω 10% ¼W	24342-054
R39	Carb 1MΩ 10% ¼W	24342-166
R40	Carb 4.7kΩ 10% ¼W	24342-100
R41	Carb 220Ω 10% ¼W	24342-058
R42	Carb 22kΩ 10% ½W	24343-118
R43	Carb 68kΩ 10% ½W	24343-131
R44	Carb 10kΩ 10% ¼W	24342-110
R45	Carb 680Ω 10% ¼W	24342-076
R46	Carb 3.3kΩ 10% ¼W	24342-094
R47	Carb 22kΩ 10% 1W	24345-518
R48	Carb 1MΩ 10% ¼W	24342-166
R49	Carb 1kΩ 10% ¼W	24342-080
R50 *	Carb 22kΩ ½W	24343-118
R51	Carb 680Ω 10% ¼W	24342-076
R52 *	Carb 22kΩ ½W	24343-118
R53	Carb 470kΩ 10% ¼W	24342-152
R54	Carb 1kΩ 10% ¼W	24342-080
R55	Carb 100Ω 10% ¼W	24342-050
R56	Carb 2.2kΩ 10% ¼W	24342-088
R57	Carb 2.2kΩ 10% ¼W	24342-088
R58	Carb 100Ω 10% ¼W	24342-050
R59	Carb 47Ω 10% ¼W	24342-037
R60	Carb 47Ω 10% ¼W	24342-037
R61	Carb 1kΩ 10% ¼W	24342-080

* R50 and R52 are matched to within 3%.

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R62	Carb 330Ω 10% 1W	24345-463
R63	Carb 470kΩ 10% ¼W	24342-152
R64 †	Carb 1.8kΩ ¼W	24342-086
R65	Carb 22kΩ 2% ¼W	8-TM 5285
R66	Carb 330Ω 10% ½W	24343-063
R67	Carb 330Ω 10% ½W	24343-063
R68	Carb 10kΩ 10% ½W	24343-110
R69	Carb 600Ω 1% 3/4W	50-TF 1101
R70	Carb 1.2kΩ 1% ½W	53-TF 1101
R71	Carb 571Ω 1% ¼W	44-TF 1101
R72	Carb 5310Ω 1% ¼W	45-TF 1101
R73	Carb 1610Ω 1% ¼W	46-TF 1101
R74	Carb 1707Ω 1% ¼W	47-TF 1101
R75	Carb 1155Ω 1% ¼W	48-TF 1101
R76	Carb 1707Ω 1% ¼W	47-TF 1101
R77	Carb 1155Ω 1% ¼W	48-TF 1101
R78	Carb 1707Ω 1% ¼W	47-TF 1101
R79	Carb 1155Ω 1% ¼W	48-TF 1101
R80	Carb 1707Ω 1% ¼W	47-TF 1101
R81	Carb 1155Ω 1% ¼W	48-TF 1101
R82	Carb 1707Ω 1% ¼W	47-TF 1101
R83	Carb 790Ω 1% ¼W	49-TF 1101
R84	Carb 570Ω 1% 3/4W	54-TF 1101
R85	Carb 570Ω 1% 3/4W	54-TF 1101
R86	WW 220Ω 5% 6W	207-TF 1101
R87	WW 220Ω 5% 6W	207-TF 1101
RV1	WW 50kΩ 10% 1W	58-TF 1101
RV2	WW 50kΩ 10% 1W	57-TF 1101
RV3	WW 100Ω 10% ½W	113-TF 1101
SA	Toggle, 2 pole, change-over	TB 23903/2
SB	Rotary, 5 pole, 4 position	TC 4428/410
SC	Rotary, 2 pole, 8 position; including screen assembly	77-TF 1101

Circuit reference	Description	M.I. code
T1	Power transformer	TM 5150/11
T2	Output transformer (20c/s - 20kc/s)	43523-002
T3	Output transformer (20kc/s - 200kc/s)	43565-001
V1	5Z4G full-wave rectifier	28113-622
V2	6CD6G Tetrode	28143-592
V3	EF95 (6AK5) Pentode	28152-487
V4	85A2 voltage stabilizer	28216-237
V5	EF95 (6AK5) Pentode	28152-487
V6	EF95 (6AK5) Pentode	28152-487
V7	EF95 (6AK5) Pentode	28152-487
V8	12AU7 double triode	28124-402
V9	6AQ5 beam tetrode	28142-502
V10	6AQ5 beam tetrode	28142-502
X1	S.T.C. type A15	25683-272
Mains lead, complete with plug, and grommet-sleeve		TM 2560BG
Knob, for ATTENUATOR switch		TB 17848/3
Knob, for RANGE switch		TB 17848/3
Knob, for SET LEVEL control		TB 17848/4
Knob, for FREQUENCY control		TB 17848/4
Front panel		TE 25247/1
Rear panel		TE 25247/2
Surround		TD 24786
Case foot		TA 11420
Side cover, for left-hand or right-hand side		TE 25595/2B
Top cover		TC 25686/1
Handle		182-TF 1101
Handle retainer		TD 25574/6A
Mains voltage tapping panel		TA 21425
Reversible reference plate, for tapping panel		TA 21484/1
Oscillator screening cover		TD 25250

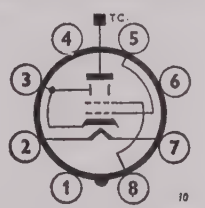
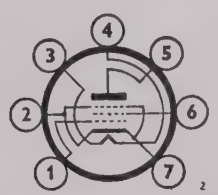
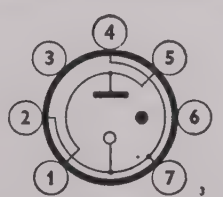
For symbols and abbreviations see introduction to this chapter

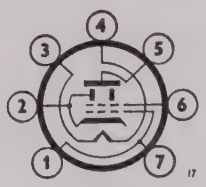
Valve Replacement Data

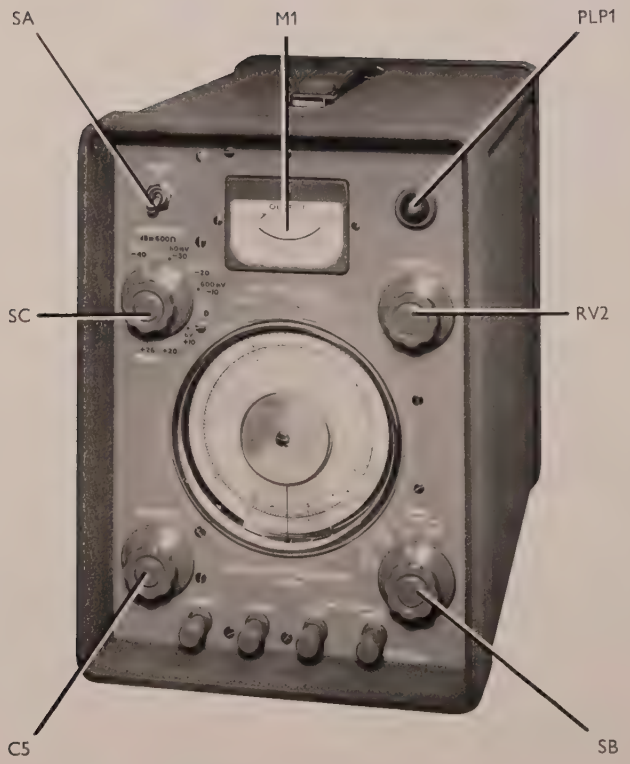
for

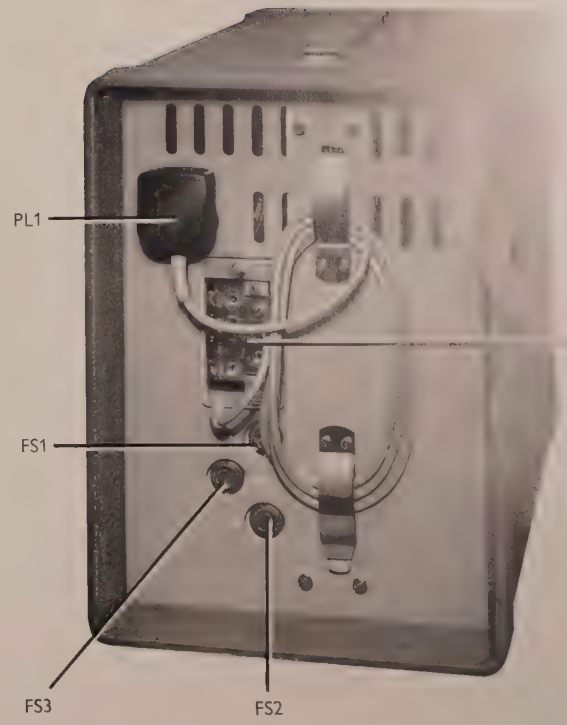
R-C OSCILLATOR TYPE TF 1101

Any valve which becomes faulty should preferably be replaced by a valve of the type originally supplied in the instrument and designated in the following table. If this is not possible, the additional data given by the table may be used as a guide to suitable alternatives.

Valve	*British Commercial Equivalent*	*British Services Equivalent*	*Base*	*U.S. Equivalent*
V1 FULL-WAVE RECTIFIER BRIMAR 5Z4G	R52 52KU	CV1863	INTERNATIONAL OCTAL 	5Z4G
V2 TETRODE BRIMAR 6CD6G			INTERNATIONAL OCTAL 	6CD6G
V3, V5, V6, V7 PENTODE MULLARD EF95		CV850	MINIATURE 7-PIN (B7G) 	6AK5
V4 VOLTAGE STABILIZER MULLARD 85A2	QS83/3 QS1209	CV449	MINIATURE 7-PIN (B7G) 	5651

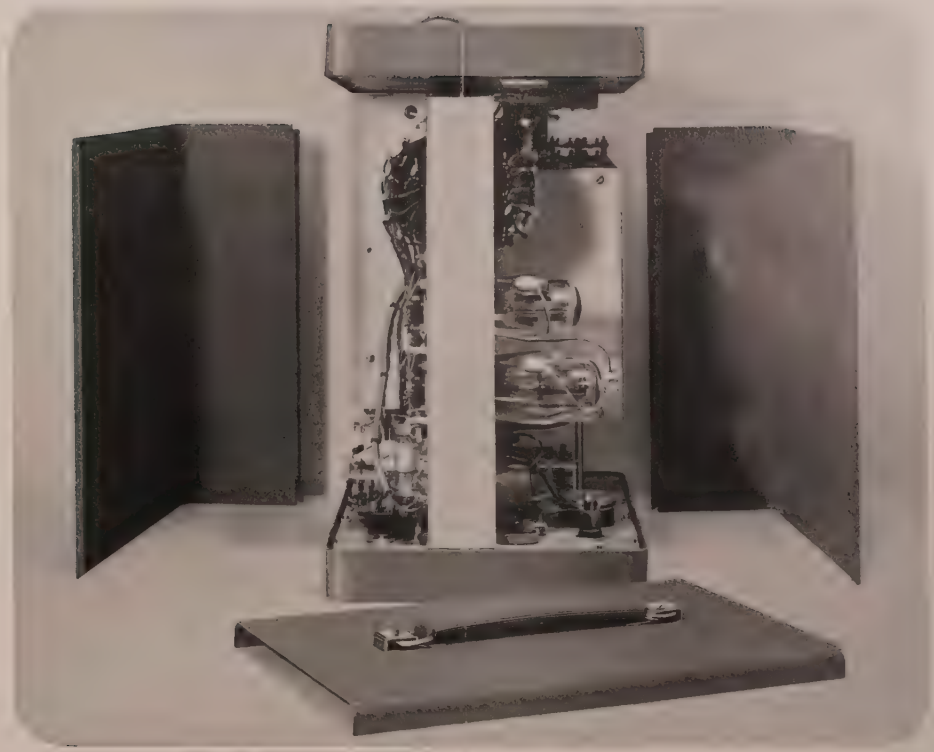
Valve	*British Commercial Equivalent*	*British Services Equivalent*	*Base*	*U.S. Equivalent*
V8 DOUBLE TRIODE BRIMAR 12AU7	ECC82	CV491	MINIATURE 9-PIN (B9G) 	12AU7
V9, V10 TETRODE BRIMAR 6AQ5	EL90	CV1862	MINIATURE 7-PIN (B7G) 	6AQ5





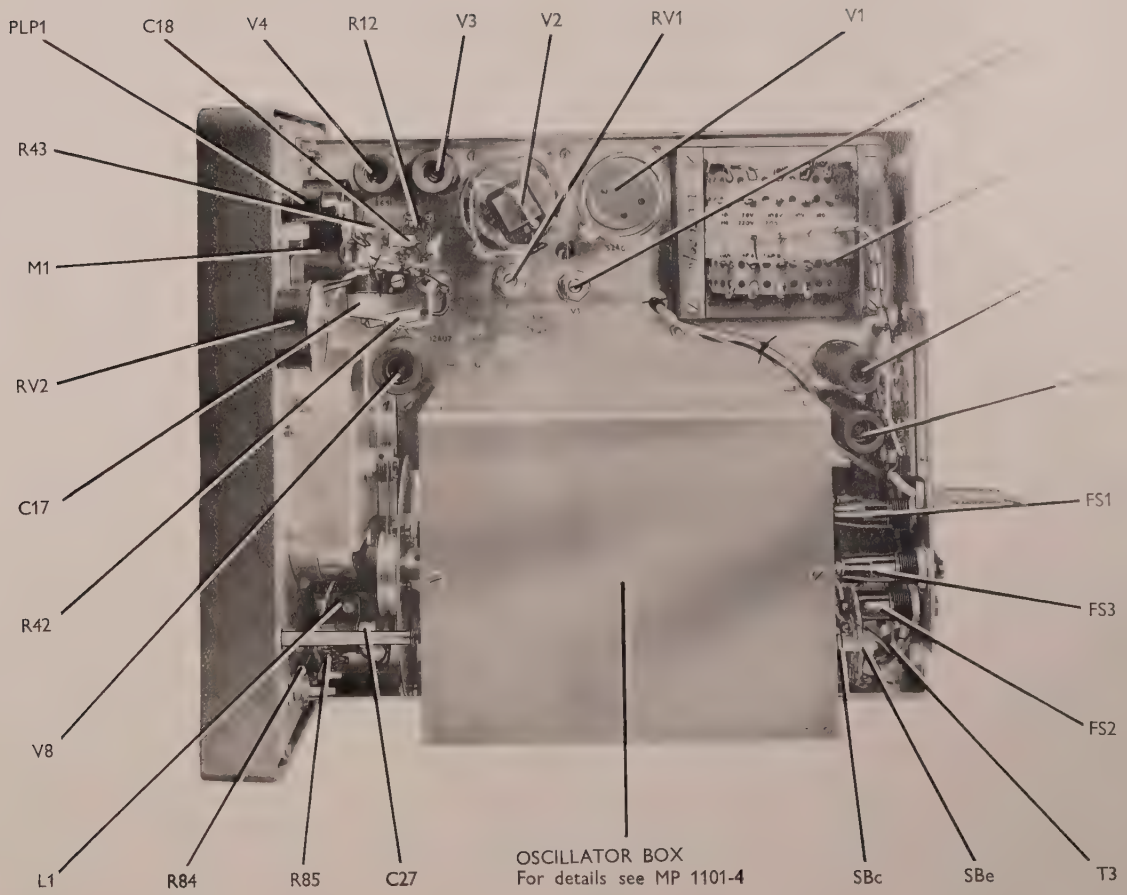
FRONT AND REAR PANELS

M.I. LTD. 1—1/57
B.W. 2.5c 3/70



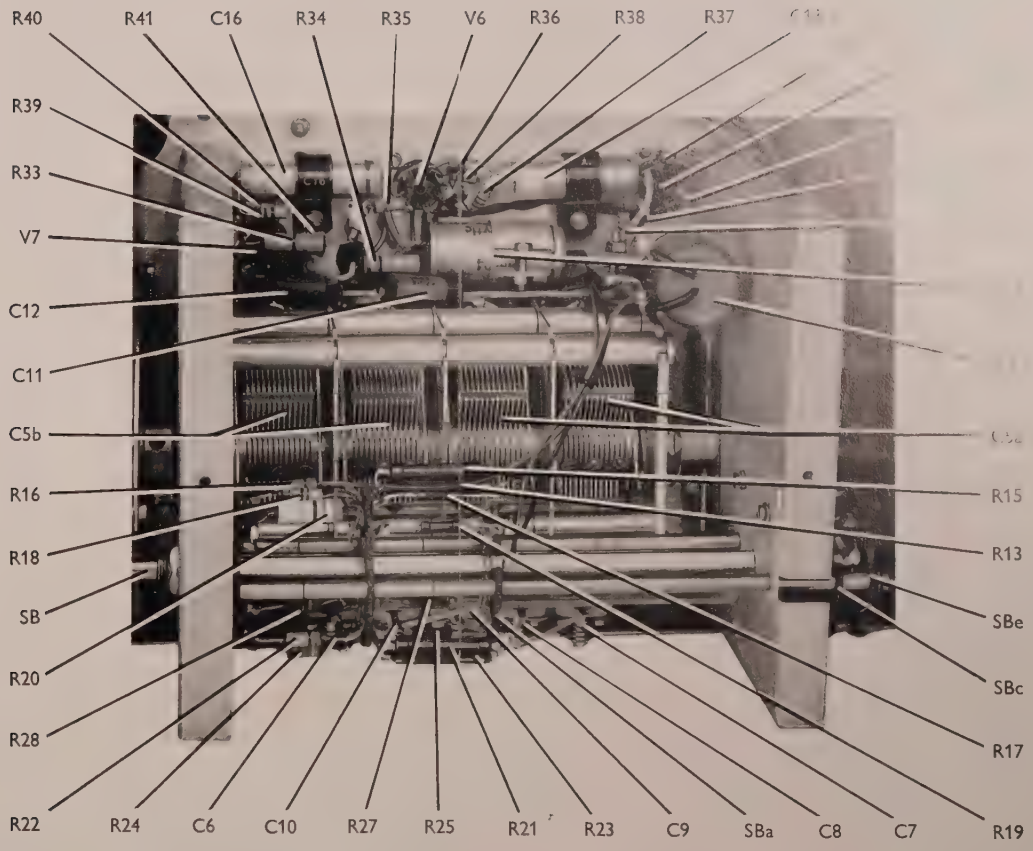
GENERAL VIEW
SHOWING COVERS REMOVED

M.I. LTD. 1—1/57
B.W. 2.5c 3/70



RIGHT-HAND SIDE
GENERAL VIEW

M.I. LTD. 2—4/60
B.W. 2.5c 3/70

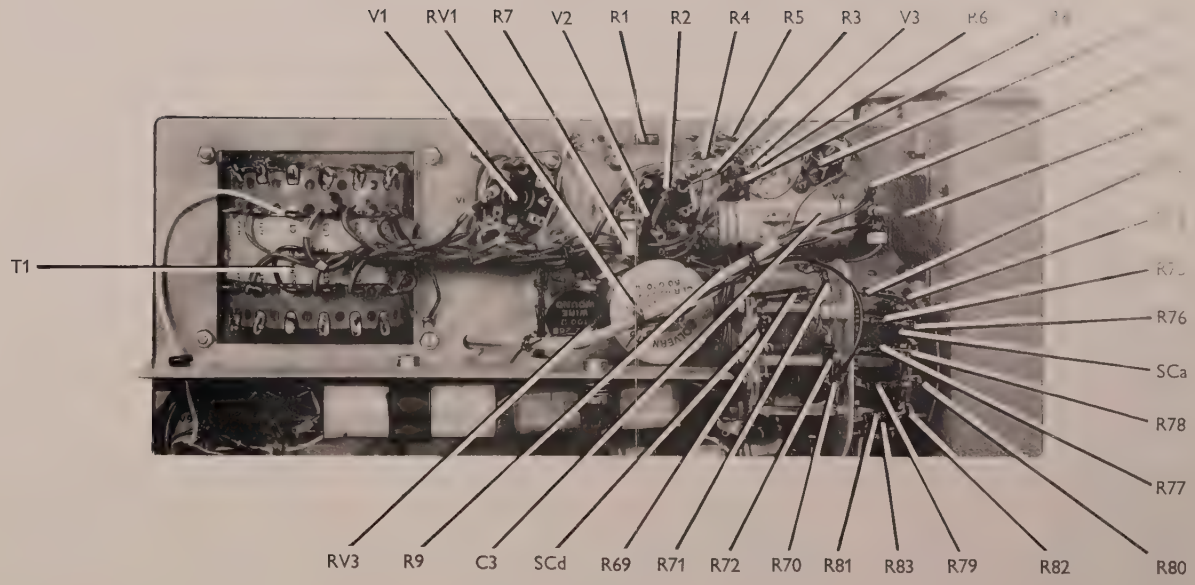


AMENDMENT

On later versions thermistor XI is mounted in a grommet at the bottom of the oscillator box

RIGHT-HAND SIDE
OSCILLATOR BOX

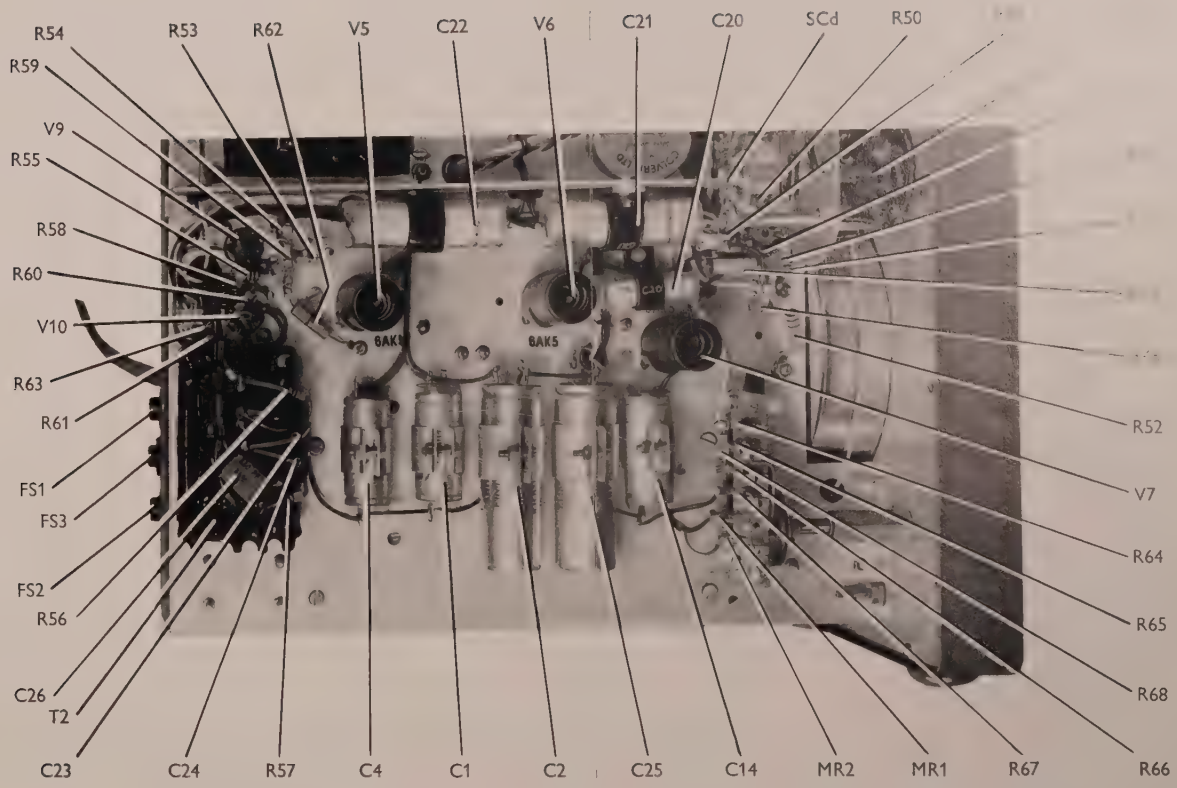
M.I. LTD. 1a—8/64
B.W. 2.5c 3/70



LEFT-HAND SIDE

POWER SUPPLY SECTION AND ATTENUATOR

M.I. LTD. 2—4 60
B.W. 2.5c 3 70



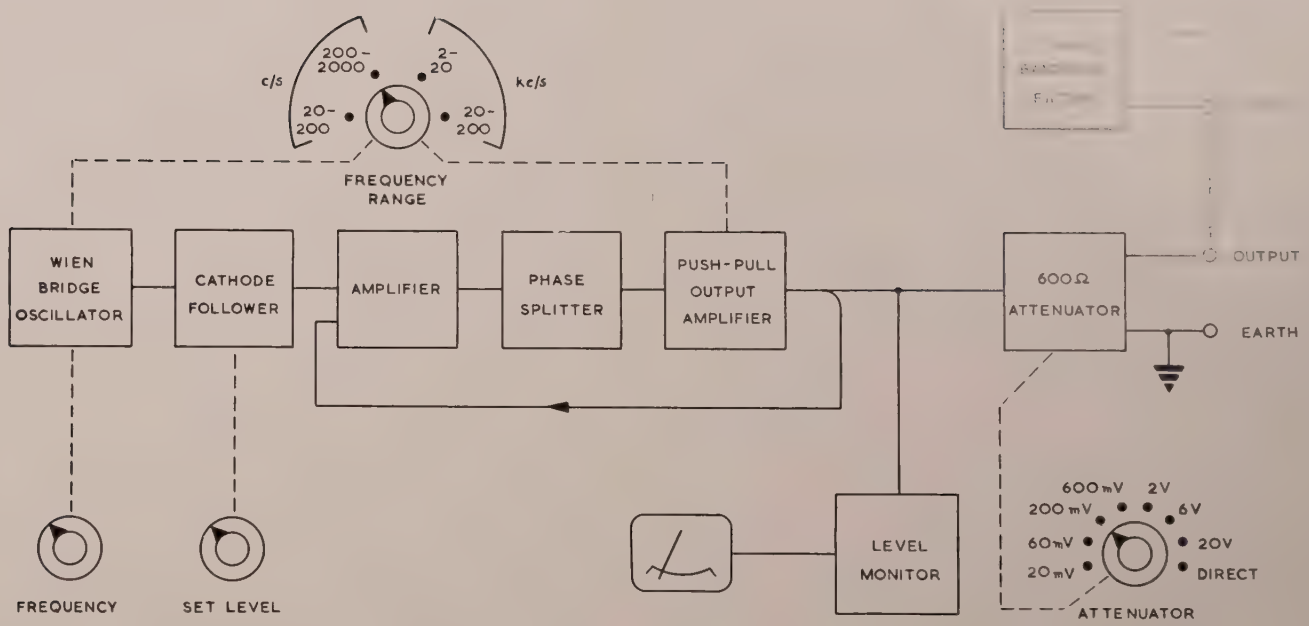
AMENDMENT

An additional capacitor C28 is fitted, across R64 and R65, at the rear of the tag board.

LEFT-HAND SIDE

OSCILLATOR AND AMPLIFIER SECTION

M.I. LTD. 1a—8/64
B.W. 2.5c 3/70



BLOCK SCHEMATIC DIAGRAM

M.I. LTD. TF1101 1—9/58
B.W. 2.5c 3/70

CIRCUIT NOTES

1. COMPONENT VALUES

   Resistors : No suffix = ohms, k = kilohms, M = megohms.
   Capacitors : No suffix = microfarads, p = picofarads.
   * value selected during test, nominal value shown.

2. SYMBOLS

   → arrow indicates clockwise rotation of knob.
   RANGE etc., external front or rear panel marking.
   ⊘ preset control.

3. SWITCHES

   Rotary switches are drawn schematically.
   Letters indicate control knob settings.
   aa = 1st section, (front panel) front
   ab = 1st section, back
   ba = 2nd section, front
   etc.

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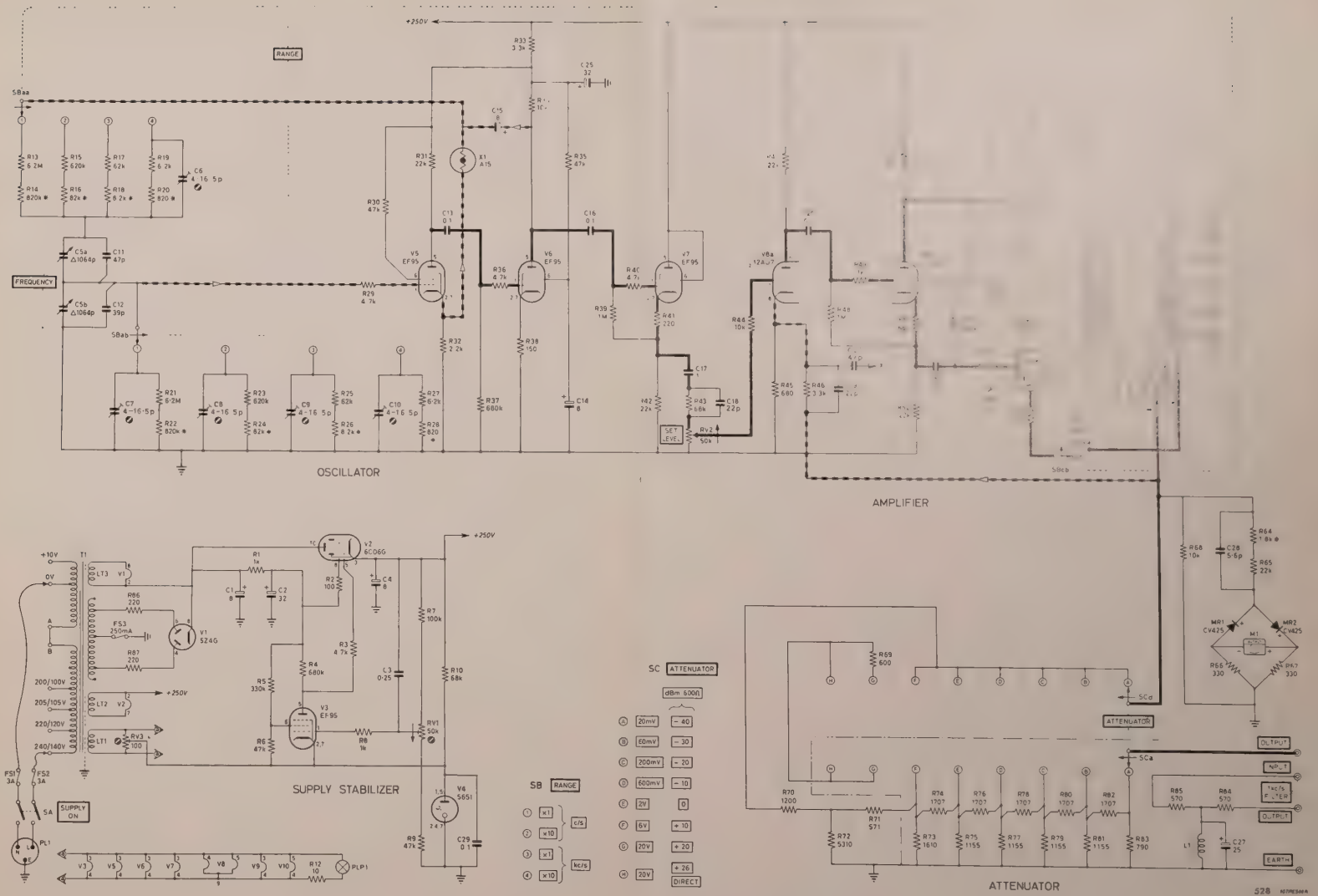

CIRCUIT DIAGRAM

DECIBEL CONVERSION TABLE

Ratio Down			*Ratio Up*	
VOLTAGE	*POWER*	*DECIBELS*	*VOLTAGE*	*POWER*
1·0	1·0	0	1·0	1·0
·9886	·9772	·1	1·012	1·023
·9772	·9550	·2	1·023	1·047
·9661	·9333	·3	1·035	1·072
·9550	·9120	·4	1·047	1·096
·9441	·8913	·5	1·059	1·122
·9333	·8710	·6	1·072	1·148
·9226	·8511	·7	1·084	1·175
·9120	·8318	·8	1·096	1·202
·9016	·8128	·9	1·109	1·230
·8913	·7943	1·0	1·122	1·259
·8710	·7586	1·2	1·148	1·318
·8511	·7244	1·4	1·175	1·380
·8318	·6918	1·6	1·202	1·445
·8128	·6607	1·8	1·230	1·514
·7943	·6310	2·0	1·259	1·585
·7762	·6026	2·2	1·288	1·660
·7586	·5754	2·4	1·318	1·738
·7413	·5495	2·6	1·349	1·820
·7244	·5248	2·8	1·380	1·905
·7079	·5012	3·0	1·413	1·995
·6683	·4467	3·5	1·496	2·239
·6310	·3981	4·0	1·585	2·512
·5957	·3548	4·5	1·679	2·818
·5623	·3162	5·0	1·778	3·162
·5309	·2818	5·5	1·884	3·548
·5012	·2512	6	1·995	3·981
·4467	·1995	7	2·239	5·012
·3981	·1585	8	2·512	6·310
·3548	·1259	9	2·818	7·943
·3162	·1000	10	3·162	10·000
·2818	·07943	11	3·548	12·59
·2512	·06310	12	3·981	15·85
·2239	·05012	13	4·467	19·95
·1995	·03981	14	5·012	25·12
·1778	·03162	15	5·623	31·62

DECIBEL CONVERSION TABLE

Ratio Down			*Ratio Up*	
VOLTAGE	*POWER*	*DECIBELS*	*VOLTAGE*	*POWER*
·1585	·02512	16	6·310	39·81
·1413	·01995	17	7·079	50·12
·1259	·01585	18	7·943	63·10
·1122	·01259	19	8·913	79·43
·1000	·01000	20	10·000	100·00
·07943	·006310	22	12·59	158·5
·06310	·003981	24	15·85	251·2
·05012	·002512	26	19·95	398·1
·03981	·001585	28	25·12	631·0
·03162	·001000	30	31·62	1,000
·02512	·0006310	32	39·81	1,585
·01995	·0003981	34	50·12	2,512
·01585	·0002512	36	63·10	3,981
·01259	·0001585	38	79·43	6,310
·01000	·0001000	40	100·00	10,000
·007943	·00006310	42	125·9	15,850
·006310	·00003981	44	158·5	25,120
·005012	·00002512	46	199·5	39,810
·003981	·00001585	48	251·2	63,100
·003162	·00001000	50	316·2	100,000
·002512	$6{\cdot}310 \times 10^{-6}$	52	398·1	158,500
·001995	$3{\cdot}981 \times 10^{-6}$	54	501·2	251,200
·001585	$2{\cdot}512 \times 10^{-6}$	56	631·0	398,100
·001259	$1{\cdot}585 \times 10^{-6}$	58	794·3	631,000
·001000	10^{-6}	60	1,000	10^{6}
·0005623	$3{\cdot}162 \times 10^{-7}$	65	1,778	$3{\cdot}162 \times 10^{6}$
·0003162	10^{-7}	70	3,162	10^{7}
·0001778	$3{\cdot}162 \times 10^{-8}$	75	5,623	$3{\cdot}162 \times 10^{7}$
·0001000	10^{-8}	80	10,000	10^{8}
·00005623	$3{\cdot}162 \times 10^{-9}$	85	17,780	$3{\cdot}162 \times 10^{8}$
·00003162	10^{-9}	90	31,620	10^{9}
·00001000	10^{-10}	100	100,000	10^{10}
$3{\cdot}162 \times 10^{-6}$	10^{-11}	110	316,200	10^{11}
10^{-6}	10^{-12}	120	10^{6}	10^{12}
$3{\cdot}162 \times 10^{-7}$	10^{-13}	130	$3{\cdot}162 \times 10^{6}$	10^{13}
10^{-7}	10^{-14}	140	10^{7}	10^{14}

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